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A NEW MUSSEL, *LAMPSILIS* (*LAMPSILIS*) *FULLERKATI* (BIVALVIA: UNIONIDAE) FROM LAKE WACCAMAW, COLUMBUS COUNTY, NORTH CAROLINA, WITH A LIST OF THE OTHER UNIONID SPECIES OF THE WACCAMAW RIVER SYSTEM

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Abstract. Twelve species of Unionidae are recognized from the Waccamaw River System, North Carolina—*Elliptio* (*E.*) *waccamawensis, complanata, icterina, angustata, folliculata; Uniomerus obesus; Anodonta* (*Pyganodon*) *cataracta cataracta; Carunculina pulla; Villosa delumbus; Lampsilis* (*Lampsilis*) *ochracea; crocata; fullerkati. L.* (*L.*) *fullerkati* is described as new, while *E. angustata, folliculata, U. obesus* and *L. crocata* are removed from the author's previous synonymies.

The Waccamaw River system lies within the Coastal Plain of North and South Carolina and is believed to have been formed during the Late Pleistocene, 32,000 to 75,000 years ago, when an uplifting of the Cape Fear Fault (roughly paralleling the Cape Fear River) resulted in the elevation of land southwest of the Cape Fear River and the subsequent pirating of the upper parts of the then Waccamaw and Little Pee Dee River drainages by the Cape Fear River system, leaving the former two confined largely to the Coastal Plain (Zullo and Harris, 1979). Zoogeographical evidence also suggests that the Waccamaw River system once drained a larger area extending into the inner Coastal Plain and Piedmont. At least five species of fishes are endemic to the

Waccamaw River system or exclusively shared with the Little Pee Dee drainage or Cape Fear River system (Shute, Shute, and Lindquist, 1981: 1). Among the mollusks are two species of endemic mussels, *Elliptio waccamawensis* and a *Lampsilis* described here, which are related to species found in both the Pee Dee (Kool *et al.* 1981; Coney *et al.* 1983a) and Cape Fear River (Coney *et al.* 1983b) systems. Kat (1983c: 143) in an elegant paper on divergence among *Lampsilis,* concluded that this, "is a species distinct from other Atlantic Slope lampsilines; it has recently diverged from *L. radiata,* with which it still exhibits considerable similarity with respect to allele frequencies and anatomical characteristics. Genetic differentiation has occurred mainly at variable-substrate loci such as *Lap.* Divergence time from *L. radiata,* is estimated at 1.3×10^5 years ago, a time consistent with the proposed age of Lake Waccamaw."

The Waccamaw River system originates from Council Mill Pond some nine miles northwest of Lake Waccamaw and it, with a number of small streams, form Friar Swamp which is the principal feeder of the lake. Three smaller streams also drain into the lake: Little, Second, and Third creeks. Acid water from these streams is neutralized by the calcareous Waccamaw limestone formation which underlies the lake and is exposed along the north shore.

Lake Waccamaw is about five miles long and three miles wide. The bottom is mainly sand and fibrous peat. Man-made canals surround much of the lake. It is drained by the Waccamaw River which flows southward for some 145 miles to its confluence with the Pee Dee River at Winyah Bay, South Carolina, an estuarine habitat, which is an effective barrier for faunal exchange between the two systems for most freshwater species. The river has a number of tributaries; the largest is Juniper Creek which is the first to enter the river from the east.

Johnson (1970) failed to recognize the species described here as distinct, since he did not separate his specimens from those of *Elliptio waccamawensis,* another endemic species. Fuller (1977: 164, fig. 3) figured both the male and female shells under "*Lampsilis radiata* (Gmelin) complex, and said

that the latter resembles no other species in Lake Waccamaw, while the male is almost indistinguishable from *E. waccamawensis* of either sex." Kat (1983c: 143, fig. 1) on the basis of electrophoretic and anatomical analyses showed that the species described here recently diverged from *Lampsilis radiata radiata* (Gmelin) and is distinct. He further compared and illustrated the other closely related *Lampsilis*.

The author is pleased to name this species for Mr. Samuel L. H. Fuller, who first figured this species, and for Dr. Pieter W. Kat who determined its relationship to other *Lampsilis*.

Lampsilis (*Lampsilis*) *fullerkati* new species
Plate 42, figs. 1–3

"*Lampsilis*" *radiata* (Gmelin) complex. Fuller 1977. Endangered and threatened plants and animals of North Carolina, p. 164, fig. 3.

Lampsilis sp. Porter and Horn 1980. Bulletin of the American Malacological Union for 1980, p. 16; Horn and Porter, 1981, Bulletin of the American Malacological Union for 1981, p. 3; Porter and Horn, 1983, American Malacological Bulletin *1*: 63; Kat, 1983c, Journal of Molluscan Studies *49*: 137, fig. 1B.

Holotype: MCZ 294576 from Lake Waccamaw, [town of] Lake Waccamaw, Columbus Co., North Carolina. Collected by W. J. Clench, K. J. Boss, and S. L. H. Fuller, October 1961.

Allotype: MCZ 294577 As above.

Paratypes: MCZ 294578 As above.

Measurements

Length	Height	Width	
mm	mm	mm	
62	32	22	Lake Waccamaw, [town of] Lake Waccamaw, Columbus Co., North Carolina. Male.
51	26	17	As above. Male. Holotype.
41	22	15	As above. Allotype.

Description. Shell small, seldom exceeding 60 mm in length. Outline elongated rhomboidal to long elliptical. Valves subinflated, thin, inequilateral. Anterior end regularly rounded; posterior end slightly biangulate and pointed toward the base in the male; female broadly rounded and somewhat expanded in the postbasal region. Ventral margin straight, slightly curved, or occasionally arcuate roughly parallel to the almost straight dorsal margin which forms an angle with, or merges imperceptably with the obliquely descending margin. Posterior ridge high somewhat angular, usually with a faint second ridge above it ending behind in a broad point in the male. Umbos rather sharp but not full or high, located in the anterior quarter of the shell, their sculpture not observed. Periostracum rather smooth with delicate growth lines, generally yellowish or brownish green, with rather fine dark greenish rays of varying width often visible over the entire surface.

Left valve with two stumpy pseudocardinal teeth, one in front of the other, often of almost equal height. Hinge line short and narrow, two short almost straight lateral teeth. Right valve with one triangular pseudocardinal, and a vestigial one before it; one lateral tooth. Beak cavities very shallow, with a few dorsal muscle scars. Anterior and posterior adductor muscle scars and pallial line distinct. Nacre purplish often lurid and spotted, somewhat iridescent.

Anatomy. Discussed by Kat (1983c).

Breeding season. September, December, March, April and June; bradytidic (Porter and Horn 1983: 65).

Habitat. Lives in sand in sluggish water.

Remarks. *Lampsilis (L.) fullerkati* is a more diminutive species than *L. radiata radiata* with a more delicate shell, a consistently sharp posterior ridge, and purplish nacre. The latter has rounded posterior ridge and the nacre is white, bluish white, or sometimes tinted with pink or salmon. *L. (L.) fullerkati* exhibits conspicuous sexual dimorphism and the female resembles no other species in Lake Waccamaw. The male shell closely resembles that of *Elliptio waccamawensis* (Lea), but the latter is sculptured on the posterior slope, the periostracum is generally more brownish and less rayed, and the nacre is white rather than purplish.

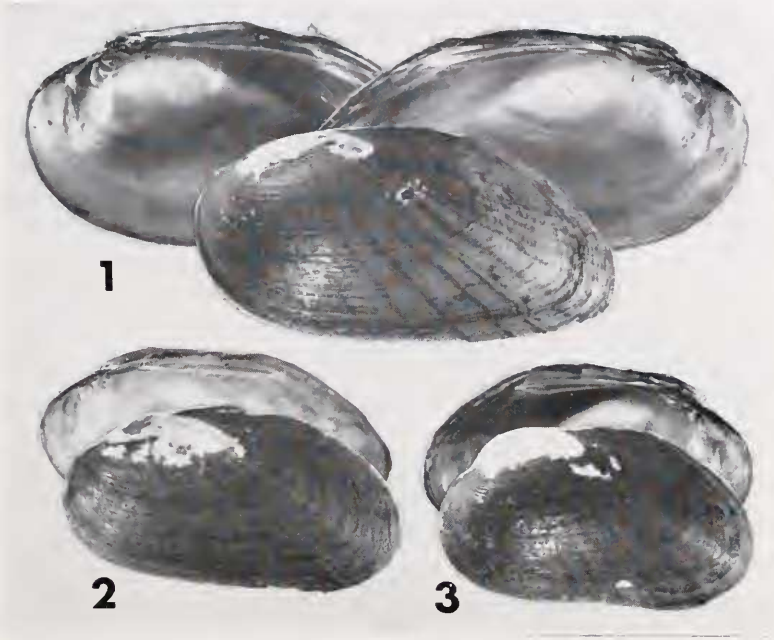

Plate 42
Lampsilis (*Lampsilis*) *fullerkati* new species

Fig. 1. Lake Waccamaw, [town of] Lake Waccamaw, Columbus Co., North Carolina. Holotype MCZ 294576. Length 51, height 26, width 17 mm. Male. (slightly enlarged).

Fig. 2. Lake Waccamaw, [town of] Lake Waccamaw, Columbus Co., North Carolina. Allotype MCZ 294577. Length 41, height 22, width 15 mm. Female. (slightly enlarged).

Fig. 3. Lake Waccamaw, [town of] Lake Waccamaw, Columbus Co., North Carolina. Paratype MCZ 294578. Length 37, height 21, width 16 [estimated, single valve] mm. Female. (slightly enlarged).

Lampsilis splendida (Lea) (Johnson 1970; 394) which ranges from Georgia to South Carolina does not overlap that of *L. r. radiata* or *fullerkati,* but according to Kat (1983c: 142) "is biochemically and anatomically closely related to both." *Lampsilis splendida* has a sharp posterior ridge like *fullerkati* but the umbos of the former are much higher, fuller and more centrally located.

Range. Southern Atlantic Slope: endemic to the Waccamaw River System; North Carolina.

Specimens Examined

WACCAMAW RIVER SYSTEM

WACCAMAW RIVER DRAINAGE—*North Carolina:* Lake Waccamaw, [town of] Lake Waccamaw, Columbus Co. (Museum of Comparative Zoology). Waccamaw River, below the Lake (Fuller, 1977: 164) [not seen].

The unionids of the Waccamaw River System

Since the publication of Johnson's (1970) work on the Unionacea of the Southern Atlantic Slope a number of papers have appeared which have taken exception to some of the classification, especially, as was predicted, among the members of *Elliptio.* Morrison (1972, 1973) correctly inferred that several valid species were included under Johnson's synonymy of *Elliptio lanceolata,* and though he did not refer to the latter's work, it was obvious that he had it in mind. Davis *et al.* (1981) in a paper on molecular genetics and speciation in *Elliptio* also take a number of names out of Johnson's synonymies, but they did not define, differentiate, or indicate the ranges of their species, nor did Coney *et al.* (1983a, b).

The following list of the unionids attempts to revise the nomenclature of the several species, based on observations and the literature since 1970. Stansbery and Clench (1978) mentioned that ten species of naiades occur in Lake Waccamaw, but did not list them. In a series of papers on the

naiades of Lake Waccamaw Porter and Horn (1980; 1983) and Horn and Porter (1981) made interesting contributions to the biological knowledge of the naiad fauna of the lake. The author is especially grateful to Dr. H. J. Porter, Curator of Invertebrate Collections, The University of North Carolina at Chapel Hill for the loan of the samples which formed the basis for these papers and for sharing his views on the nomenclature employed in them.

Several papers have appeared on the genetic relationships among recent genera of Unionacea since Johnson's (1970) revision of the species. The latest of these, by Davis and Fuller (1981) lists the more important previous classifications and presents a new one of their own. In the following list, the classification used in 1970 is retained, not because it is necessarily better, but because a discussion of higher categories is not the purpose of this paper.

All of the species listed here occur in Lake Waccamaw. Little is known about most of them in the rest of the river system, except as mentioned below.

ELLIPTIO (ELLIPTIO) WACCAMAWENSIS (Lea 1863)

Johnson 1970, p. 313, pl. 7, figs. 6, 7; Fuller 1977, p. 162, figs. 1, 2; Porter and Horn 1980, p. 15; Horn and Porter 1981, p. 15; Davis *et al.* 1981, fig 3, H; Porter and Horn 1983.

Johnson's figure 6, cited above, is typical of specimens found in the lake. They achieve greater size and are less eroded in the canals outside of the lake, figure 7.

ELLIPTIO (ELLIPTIO) COMPLANATA (Lightfoot 1786) Plate 43, fig 1

Johnson 1970, p. 322 (records for the Waccamaw River System) pl. 8, fig. 6; Davis *et al.* 1981, fig. 3, J, K, L; Kat 1982, 1983a.

Johnson's figure 6, cited above, is typical of specimens found in the lake. They achieve greater size and are less eroded in the Waccamaw River below the lake.

ELLIPTIO (ELLIPTIO) ICTERINA (Conrad 1834)

Johnson 1970, p. 325, pl. 9, figs. 3–10, pl. 10, figs. 1–3; Davis *et al.* 1981, fig. 3, G, I. Morrison (1972: 38) suggested that *E. icterina* is a synonym of *E. congaraea* (Lea 1831), Johnson 1970, p. 308, pl. 5, figs. 1–8.

Elliptio raveneli (Conrad [May 1834]). Porter and Horn 1980, p. 15.

ELLIPTIO (ELLIPTIO) ANGUSTATA (Lea 1831)

Johnson 1970, p. 333 (*partim*), pl. 11, fig. 3; Morrison 1972; p. 38; Morrison 1973, p. 14; Moore *et al.* 1983, p. 95.

Elliptio producta (Conrad 1836). Johnson 1970, pl. 10, fig. 10; Porter and Horn 1980, p. 14, footnote 1; Porter and Horn 1983, p. 61, footnote 2.

Elliptio fisheriana (Lea 1838). Porter and Horn 1980, p. 14 (*non* Lea).

Elliptio lanceolata (Lea 1828). Fuller 1972; Porter and Horn 1980, p. 16; Davis *et al.* 1981, p. 135, fig. 3B, specimen from Lake Waccamaw; Coney, Moore, and Kool, 1981, 1983 (*non* Lea).

Morrison (1973, p. 14) stated, "The dark species, *E. angustatus* is completely biologically separate from the golden, sand-dwelling *Elliptio lanceolatus* (Lea 1828). The true species *E. lanceolatus* is known only from five river systems in Maryland, Virginia, and North Carolina."

Coney, *et al.* (1983a) suggested that there is an undescribed member of the *Elliptio lanceolata* species group in the Pee Dee River system of which the shell morphology appears to be intermediate between that of *Unio emmonsii* Lea 1857 (Johnson 1970, pl. 11, fig. 4) from the Roanoke River system and *Unio perlatus* Lea 1863 (Johnson 1970, pl. 10, fig. 9) from the Cape Fear River system.

Morrison (1972: 38) stated, "In the Potomac River System, *Elliptio complanatus* Lightfoot, and *Elliptio angustata* Lea, 1831 (+*producta* Conrad, 1836) are living side by side . . . ." He (1973: 14) also stated that *E. angustatus* [sic] occurred in both South and North Carolina, northward as far as the Schuylkill River, near Philadelphia, Pennsylvania.

ELLIPTIO (ELLIPTIO) FOLLICULATA (Lea 1838)

Johnson 1970, p. 333 (*partim*); Morrison 1972, p. 38; Porter and Horn 1981, p. 16; Davis *et al.* 1981, p. 150, fig 3 A.

Elliptio sp. Fuller 1977, p. 175, fig. 7.

Davis *et al.* (1981: 150) stated that, "Two lanceolate species of *Elliptio* live side by side in the sandy-bottom shallows of Lake Waccamaw. One of these resembles *E. lanceolata* (Lea) [*E. angustata* (Lea)] and the other resembles the holotype of *Unio folliculatus* Lea 1838, USNM 86006, from the Savannah River, Georgia". The authors are probably correct in changing *Unio perlatus* Lea 1863 to this synonymy from that of *E. arctata* (Conrad) where it was placed by Johnson (1970: 331).

UNIOMERUS OBESUS (Lea 1831) Plate 43, fig. 2

Uniomerus tetralasmus (Say). Johnson 1970, p. 339 (*partim*), pl. 12, figs. 1–6 (records, p. 343).

Uniomerus carolinianus (Bosc 1801). Morrison 1976, p. 10.

Morrison gave a corrected synonymy of *U. obesus,* but used Bosc's name as earlier. Fuller (1972: 72) had previously shown that Bosc's name should be considered a *nomen dubium.*

Elliptio cistelliformis (Lea 1863). Davis *et al.* 1981, p. 150, fig. 3 F. The type is figured here, Plate 43, fig. 3. The authors claim this to be Fuller's (1977: 189, fig. 13) unidentified *Elliptio.* Johnson (1970: 317) incorrectly included *U. cistelliformis* Lea under the synonymy of *E. complanata* (Lightfoot).

ANODONTA (PYGANODON) CATARACTA CATARACTA Say 1817

Johnson 1970, p. 356, pl. 14, figs. 3, 4; pl. 15, fig. 1; Kat 1983b.

Anodonta teres Conrad 1834. Morrison 1972, p. 39; Porter and Horn 1980, p. 13. Removed from the synonymy of the above without explanation.

CARUNCULINA PULLA (Conrad 1838)

Johnson 1967, p. 127, figs. 1–4; Johnson 1970, p. 370, pl. 17, figs. 4–7; Fuller 1977, p. 159.

Toxolasmus [*sic*] *pullus* (Conrad). Porter and Horn 1980, p. 16.

Johnson (1970: 369) discussed the fact that *Unio lividus* Rafinesque 1831 is a *nomen dubium* and that therefore *Toxolasma* should be disregarded.

VILLOSA DELUMBUS (Conrad 1834)

Johnson 1970, p. 375, pl. 18, figs. 4–8.

Villosa ogeecheensis (Conrad 1838). Porter and Horn 1980, p. 13.

V. delumbus is the male shell while *ogeecheensis,* figure 8 cited above, is that of the female.

Plate 43

Elliptio (*Elliptio*) *complanata* (Lightfoot 1786)

Fig. 1. Waccamaw River, Wachsaw Landing, 2 mi. E. of Murrells Inlet, Georgetown Co., South Carolina. MCZ 185714. Length 86, height 44, width 24 mm. (reduced).

Uniomerus obesus (Lea 1831)

Fig. 2. Waccamaw drainage canal, 1 mi. E Dupree, Columbus Co., North Carolina. MCZ 214258. Length 63, height 35, width 24 mm. (slightly enlarged).

Fig. 3. *Unio cistelliformis* Lea 1863, Proceedings of the Academy of Natural Sciences of Philadelphia *15*: 193 (Neuse River near [6 mi. E] Raleigh [Wake Co.], North Carolina); 1866, Journal of the Academy of Natural Sciences of Philadelphia (2) *6*: 19, pl. 6, fig. 17; 1867, Observations on the Genus Unio *11*: 23, pl. 6, fig. 17. Figured holotype National Museum of Natural History 85533. Length 46; height 26; width 23 mm. (reduced).

Lampsilis (*Lampsilis*) *crocata* (Lea 1841)

Fig. 4. *Unio crocatus* Lea 1841, Proceedings of the American Philosophical Society *2*: 31 (Savannah River, Georgia); 1842, Transactions of the American Philosophical Society *8*: 238, pl. 22, fig. 52; 1842, Observations on the Genus Unio *3*: 76, pl. 22, fig. 52. Allotype National Museum of Natural History 84908.2. Length 42, height 27, width 19 mm. Male. (slightly reduced).

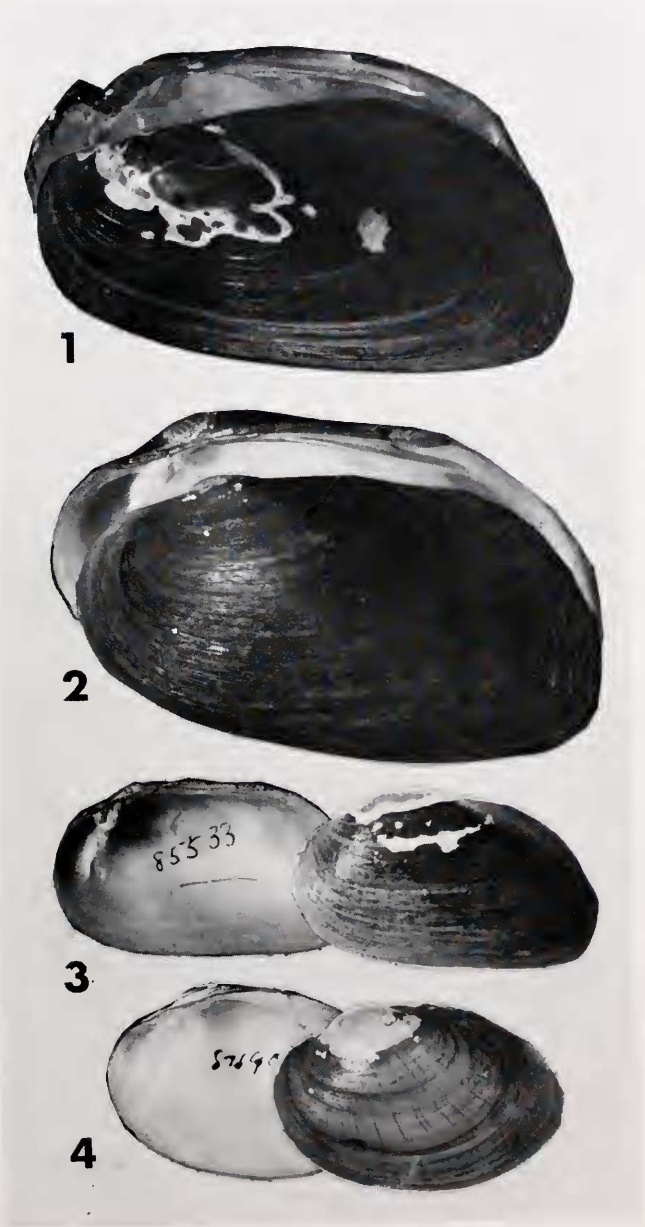

Plate 43

LAMPSILIS (LAMPSILIS) OCHRACEA (Say 1817)

Johnson 1970, p. 388, pl. 21, figs. 4, 5; Bereza and Fuller 1975 p. 42; Fuller 1977, p. 182, figs. 10–12; Johnson 1980, p. 99; Kat 1983c, fig. 1, C, D.

Leptodea fluviatilis (Gmelin 1791). Morrison 1975, p. 38.

Leptodea ochracea (Say 1817). Porter and Horn 1980, p. 15; Horn and Porter 1981; Porter and Horn 1983.

LAMPSILIS (LAMPSILIS) CROCATA (Lea 1841) Plate 43, fig. 4, Text fig. 1. Porter and Horn 1980 and 1983.

Johnson (1970: 382) placed *Unio crocatus* under the synonymy of *Lampsilis cariosa* (Say 1817) thinking that the type specimens were young specimens of the latter on the basis of their having rather heavy valves and pyramidal pseudocardinal teeth, even though they have fine, faint, greenish rays over the entire surface similar to those of *L. ochracea* and have slightly sharper posterior ridges than either *cariosa* or *ochracea*. Morrison (ms. note, 1971) regarded *crocata* as distinct. Porter and Horn (1980) noted differences in the glochidia between populations of *L. crocata* and *ochracea* in Lake Waccamaw where the two species are not easy to separate conchologically except that the latter species has lamelate rather than pyramidal pseudocardinal teeth. Two specimens MCZ 224049 and 294816 from the Waccamaw River, Wachsaw Landing, 2 miles East of Murrells Inlet, Georgetown County, South Carolina closely resemble the types figured here. *L. crocata* is not known to occur in the river systems between the Savannah and the Waccamaw.

Lampsilis (*Lampsilis*) *crocata* (Lea 1841)

Text figure 1. *Unio crocatus* Lea 1841. Savannah River, Georgia. Figured holotype National Museum of Natural History 84901.1. Length 45; height 30, width 20.5 mm. Female (slightly reduced). The author is grateful to Dr. Joseph Rosewater for the loan of the type specimens and to Mr. David Backus for taking some of the photographs.

LAMPSILIS (LAMPSILIS) FULLERKATI new species. Plate 42, figs. 1–3.

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Listed are: Elliptio lanceolata-complex form E. fisheriana (Lea 1838)
Elliptio icterina (Conrad 1834)—species complex
Elliptio raveneli (Conrad 1834)—species complex
Uniomerus obesus (Lea 1831)

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MISCELLANY

Fusconaia collina (Conrad), from the James River, Virginia, an additional note

by
Richard I. Johnson and Kenneth J. Boss

When Johnson and Clarke (1983) described a spiny mussel, *Elliptio* (*Canthyria*) *steinstansana,* from the Tar River, North Carolina, they assumed that the specimens figured by Boss and Clench (1967, pl. 15, figs. 2 and 3) as *Pleurobema* [=*Fusconaia*] *collina* (Conrad) were correctly identified and that the locality, North Carolina, was incorrect. However, the lot, National Museum of Natural History 84376, could not be studied since it was on loan to the Ohio State Museum. It was recently returned and through the kindness of Dr. Joseph Rosewater we have been able to examine it. The specimens numbered 84376.1-4, and 84376.6 (a single valve) are indeed *Fusconaia collina* (Conrad). Specimen 84376 has "N. Car. Emmons" pencilled in one of the valves. E. Emmons collected a number of shells from the Cape Fear, Neuse, and Roanoke River Systems in North Carolina for Isaac Lea, some of which the latter described as new. Unless *F. collina,* now known only from the James River System, Virginia, is eventually found in North Carolina, it is assumed that the locality data with these shells is incorrect. Boss and Clench (1967, pl. 15, fig. 2) gave a dorsal view of specimen 84376.2 which is illustrated here, ventrally, Text fig. 1. Unfortunately the specimen they illustrated ventrally 84376.5 (pl. 15, fig. 3) is a young specimen of *Elliptio* (*Canthyria*) *spinosa* (Lea), known only from the Altamaha River System, Georgia. Of the three known spined species of unionids this is the only one with long spines that are often hollow, that has a faintly greenish periostracum,and is less rhomboidal than the other two.